

REMARKS

Reconsideration and allowance are respectfully requested in light of the above amendments and the following remarks.

To overcome the obviousness-type double patenting rejections, a terminal disclaimer is submitted herewith, to expedite issuance. However, it is noted that the filing of this terminal disclaimer is to expedite issuance and is not an acquiescence that the claims are patentably indistinct.

To overcome the objection to the continuation data, the specification is amended and a corrected double-column sheet is provided.

Claims 3-6 and 8 are hereby amended to clarify the claimed subject matter. For the convenience of the Office, marked up versions of the amended claims are attached. Support for the amended language is found in Fig. 5 and the discussion at original patent col. 8, line 62 et seq.

The Original Letters Patent No. 5,745,182 was surrendered on April 6, 2001.

A draft Reissue Declaration is attached for approval prior to execution. It is noted that both the Statement under 37 CFR 3.73(b) and the Assent of Assignee were filed and accepted in parent reissue application no. 09/559,627, without objection to

absence of a date. It is hereby noted that these documents were signed during the period of April 18-26, 2000. Copies thereof were filed in the present application. If new signed and dated documents are required, they will be submitted subsequently.

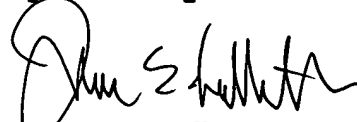
To expedite issuance, an executed Reissue Declaration, a re-executed Statement under 37 CFR 3.73(b) and a re-executed Assent of Assignee will be filed as soon as possible.

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In light of the foregoing, a Notice of Allowance is respectfully solicited.

If any issues remain which may best be resolved through a telephone communication, the Examiner is requested to telephone the undersigned at the local Washington, D.C. telephone number listed below, in order to expedite consideration and allowance of this application.

Respectfully submitted,



James E. Ledbetter
Registration No. 28,732

Date: November 24, 2003

JEL/att
Attorney Docket No. JEL 29186C-RE-DIV2
STEVENS, DAVIS, MILLER & MOSHER, L.L.P.
1615 L Street, NW, Suite 850
P.O. Box 34387
Washington, DC 20043-4387
Telephone: (202) 785-0100
Facsimile: (202) 408-5200

Marked Up Version of Claims

4. (Amended) A method in accordance with claim 3, wherein said motion vector MV1 between the motion-compensated image and said one reference image R1 of said plurality of reference images is calculated from a motion of at least one block unit at said second set time interval, said at least one block unit being a part of said input motion-compensated image and comprising a plurality of pixels.

5. (Amended) A method in accordance with claim 3, wherein step (c) comprises ~~obtaining said motion vector MV2 from a mean of said motion vector MV1 and said motion vector MV3, and said pixels positioned peripherally are valued~~ calculating said respective pixel values in accordance with ~~an average weighting a weighted average~~ inversely proportional to distance from pixels of the reference image R1 and the reference image R2.

6. (Amended) A method of determining motion compensation for an input image, said method comprising the steps of:

(a) providing a first motion vector MV1 between the input image and a reference image part r1 of one reference image R1 of

a plurality of reference images at a second set time interval T2 between said input image and said one reference image R1;

(b) calculating a second motion vector MV2 between the input image and a reference image part r2 of another reference image R2 of said plurality of reference images at a first set time interval T1 between said input image and said another reference image R2, said second motion vector MV2 being parallel to said first motion vector MV1 and having a magnitude satisfying the relation $MV2 = MV1 \cdot (T1/T2)$;

(c) calculating pixel values of said reference image parts r1 and r2 from peripheral pixels at positions corresponding to said first and second motion vectors MV1 and MV2, wherein said reference images R1 and R2 are previous to said input image in a time sequence; and

(d) calculating, motion compensated pixel values of said input image from said calculated pixel values of said reference image parts r1 and r2 to determine said motion compensation.

7. (Previously Presented) A method for determining a motion-compensated image, said method comprising the steps of:

(a) providing a first motion vector MV1 between the motion-compensated image and a reference image part r1 of one reference image R1 of a plurality of reference images at a second set time

interval T2 between said motion compensated image and said one reference image R1;

(b) calculating a second motion vector MV2 between the motion-compensated image and a reference image part r2 of another reference image R2 of said plurality of reference images at a first set time interval T1 between said motion compensated image and said another reference image R2, said second motion vector MV2 being parallel to said first motion vector MV1 and having a magnitude satisfying the relation $MV2 = MV1 \cdot (T1/T2)$;

(c) calculating pixel values of said reference image parts r1 and r2 from peripheral pixels at positions corresponding to said first and second motion vectors MV1 and MV2, wherein said reference images R1 and R2 are previous to said motion-compensated image in a time sequence; and

(d) calculating motion-compensated pixel values from said calculated pixel values of said reference image parts r1 and r2 to determine said motion-compensated image.

8. (Amended) An apparatus for determining motion compensation for an input image, said apparatus comprising:

(a) means for providing a first motion vector MV1 between the input image and a reference image part r1 of one reference image R1 of a plurality of reference images at a second set time

interval T2 between said input image and said one reference image R1;

(b) means for calculating a second motion vector MV2 between the input image and a reference image part r2 of another reference image R2 of said plurality of reference images at a first set time interval T1 between said input image and said another reference image R2, said second motion vector MV2 being parallel to said first motion vector MV1 and having a magnitude satisfying the relation $MV2 = MV1 \cdot (T1/T2)$;

(c) means for calculating pixel values of said reference image parts r1 and r2 from peripheral pixels at positions corresponding to said first and second motion vectors MV1 and MV2, wherein said reference images R1 and R2 are previous to said input image in a time sequence; and

(d) means for calculating motion-compensated pixel values of said input image from said calculated pixel values of said reference image parts r1 and r2 to determine said motion compensation.

9. (Previously Presented) An apparatus for determining a motion-compensated image, said apparatus comprising:

(a) means for providing a first motion vector MV1 between the motion-compensated image and a reference image part r1 of one

reference image R1 of a plurality of reference images at a second set time interval T2 between said motion compensated image and said one reference image R1;

(b) means for calculating a second motion vector MV2 between the motion-compensated image and a reference image part r2 of another reference image R2 of said plurality of reference images at a first set time interval T1 between said motion compensated image and said another reference image R2, said second motion vector MV2 being parallel to said first motion vector MV1 and having a magnitude satisfying the relation $MV2 = MV1 \cdot (T1/T2)$;

(c) means for calculating pixel values of said reference image parts r1 and r2 from peripheral pixels at positions corresponding to said first and second motion vectors MV1 and MV2, wherein said reference images R1 and R2 are previous to said motion-compensated image in a time sequence; and

(d) means for calculating motion-compensated pixel values from said calculated pixel values of said reference image parts r1 and r2 to determine said motion-compensated image.

This is a reissue of U.S. Patent No. 5,745,182 which is a division of application Ser. No. 07/970,046 filed Nov. 2, 1992, now U.S. Pat. No. 5,369,449. This application is a continuation of reissue application no. 09/559,627, filed April 27, 2000 and has the following co-pending related reissue applications: 09/833,680 filed April 13, 2001; 09/833,769 filed April 13, 2001, and 09/866,811 filed May 30, 2001.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method for determining motion compensation of a moving image to be utilized in an apparatus which requires a prediction of a moving image such as an image transmission apparatus and an image apparatus.

2. Description of the Prior Art

With the progress of semiconductor technologies, methods for determining motion compensation to be utilized for a transmission of an image and a compression of an image have been widely used in many fields in recent years. Among such conventional methods for compensating for motion of a moving image, there is one method for compensating for motion of a moving image based on one piece of a reference image.

FIG. 6 is a diagram for showing the concept of the conventional method for compensating for motion of an image. Referring to FIG. 6, a moving image signal is a set of images which are sampled with an equal time interval t_0 on the time axis. For example, an NTSC signal has images sampled at every $1/60$ second for each field and a PAL signal has images sampled at every $1/50$ second for each field. When a certain object of which images are to be picked up is moving, for example, the spatial position of an object A in an M-th image is deviated from the spatial position of an object A' in an (M-1)-th image by a portion of a move of the object during a period of t_0 . Now, consider a case for predicting the M-th image from the (M-1)-th image. In order to make a determination of the M-th image with a high level of precision by compensating for motion of the object from an input image to a reference image during a time difference of t_0 , the M-th image is divided into blocks including at least one pixel, and a move of each block from the (M-1)-th image to the M-th image is detected so that a pixel value of the image at a position deviated by the portion of this move is set as a determined value. This will be explained with reference to FIG. 6. To obtain a determined value of a pixel X of the M-th image, a pixel X' at the same spatial position as the spatial position of the pixel X in the (M-1)-th image is deviated by a detected move MV of a block unit including the pixel X', so that a pixel X'' is obtained. This pixel X'' is then used as a determined value of the pixel X. In FIG. 6 the block is assumed to have a size of 3×3 .

When a signal is an interlace signal, there are many alternative cases considered for predicting compensation for motion of an image. For example, either a frame or a field is used for the image, and a frame is used for a reference image and a field is used for an input image, etc. The basic principle is as explained with reference to FIG. 6 above. As one of the examples of the above method for predicting motion compensation, there is Recommendation 723, "Transmission of component-coded digital television signals for contribution-quality at the third hierarchical level of CCITT Recommendation G.702" which was standardized by the CCITT (Commission Mixte CCIR/CCITT pour les Transmissions Televisuelles et Sonores 3). In this recommendation, a determination of motion compensation between frames and a determination of motion compensa-

tion between fields are suitably changed over between the two cases. As described above, according to the conventional method for determining motion compensation of an image, a determination is made by compensating for motion of the image based on detected motion of the image. Therefore, the conventional predicting method can predict motion compensation with a high level of precision even if an image is a moving image including movement.

The above-described conventional method for determining motion compensation, however, has problems that it is not possible to accurately determine motion compensation and that, even if it is possible to correctly determination of motion compensation, the image density of an image to be referred to becomes the image density of a reference image, which makes it impossible to make prediction at a higher level of precision.

For example, in the case of determining motion compensation by using an interlace signal as a frame and generating a block from this frame, frames are combined together to compensate motion of an image by disregarding a difference in sampling positions, due to a time difference, between two fields within a frame. Accordingly, when correct sampling positions of the fields are considered, there is such a case that motion compensated in the first field and motion compensated in the second field do not coincide with each other. An example of this case is shown in FIGS. 7A to 7C. Referring to FIGS. 7A to 7C, an input signal is an interlace signal (FIG. 7A). Interlace signals are combined together in a frame to determine motion compensation. When a vertical component of a motion detected now is 1, the first field of the M-th frame is predicted from the second field of the (M-1)-th frame and the second field of the M-th frame is predicted from the first field of the (M-1)-th frame, as shown in FIG. 7B. Moves in the correct field positions is shown in FIG. 7C. As is clear from FIG. 7C, the motion for effecting compensation in the first field of the M-th frame do not coincide with the moves for effecting compensation in the second field of the M-th frame. As explained above, when motion compensation of an image is made by handling an interlace image as a frame, the motion for effecting compensation are different between the first field and the second field. In a vector in which this phenomenon occurs, there is a problem that the precision of the level of prediction is deteriorated.

Next, consider a case of determining motion compensation of an image as an image of a correct position without disregarding a time difference of sampling between images as described above. As examples of this case, there is a case where motion compensation is determined for an interlace signal by generating a block from a field, and a case where motion compensation is determined for a noninterlace signal. In the above cases, motion compensation is predicted by using an image at a position of a correct time. Therefore, there arises no such problem which occurs in the case of determined motion compensation by generating a block from a frame of the interlace signal as described above. However, in this case, motion compensation is determined from one piece of reference image and the pixel density of an image to be referred to becomes the pixel density of the reference image, so that there is a limit to carrying out a determination of motion compensation at a higher level of precision. FIG. 8 shows a case of determined move compensation by generating a block from a field for an input of an interlace signal. In this case, determination of motion compensation is carried out by using a field image as a reference image. Therefore, when a motion vector is 0 there is no sampling point at a position necessary for making a determination on the reference image and, accordingly, a

SUPPLEMENTAL REISSUE DECLARATION

We, as the below-named inventors, hereby declare that our residences, post office addresses and citizenships are as stated below adjacent our names, that we verily believe we are the original, first and joint inventors of the invention described and claimed in Letters Patent No. 5,745,182 issued April 28, 1998 and in the specification filed April 27, 2000, serial number 09/559,627, and for which invention we solicit a reissue patent; that we have reviewed and understand the contents of the present application filed May 30, 2001, serial number 09/866,811, including the claims; that we acknowledge our duty to disclose information of which we are aware which is material to the examination of this Reissue Application in accordance with Title 37, Code of Federal Regulations, §1.56(a); and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States prior to filing of Application Serial No. 08/278,010 (from which Patent 5,745,182 issued) by us or our legal representatives or assigns, except as follows:

Japanese Patent Application No. 3-293004 filed November 8, 1991; and
Japanese Patent Application No. 4-181980 filed July 9, 1992.

The priority of Japanese application nos. 3-293004 and 4-181980 was claimed in said U.S. application and is also hereby

claimed in this Reissue Application and certified copies are available in the patent file.

We further declare that we believe said Letters Patent is, through errors which arose without deceptive intent on the part of the applicants, wholly or partially inoperative by reason of claiming more or less than we had a right to claim in the patent. The errors relied upon as the basis for reissue include the inclusion of the language "from a motion of at least one block unit" and "said at least one block unit being a part of said input image and comprising a plurality of pixels" in claim 1, thus making claim 1 narrower than necessary to distinguish over the prior art in at least this respect.

Same as 09/559,627

All errors in the patent which are being corrected in the present reissue application up to the time of filing of this Declaration arose without any deceptive intention on the part of the applicants.

We hereby appoint the following as our attorneys of record with full power of substitution and revocation to prosecute this application and to transact all business in the Patent and Trademark Office:

James E. Ledbetter, Registration No. 28,732; Thomas P. Pavelko, Registration No. 31,689; and Anthony P. Venturino, Registration No. 31,674.

All correspondence in connection with this application should be sent to:

STEVENS DAVIS, MILLER & MOSHER, L.L.P.
1615 L Street, N.W., Suite 850
Washington, D.C. 20036
Telephone: (202) 408-5100
Facsimile: (202) 408-5200

We, as the undersigned inventors, further declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the reissue application or of any reissue patent to issue thereon.

Takeshi YUKITAKE

(Signature)

(Date)

Residence: Yokohama-shi, Japan

Citizenship: Japan

Post Office Address: 1114-D-403, Kamisugetacho, Hodogaya-ku,
Yokohama-shi, Japan

Shuji INOUE

(Signature)

(Date)

Residence: Yokohama-shi, Japan

Citizenship: Japan

Post Office Address: 1114-C-404, Kamisugetacho, Hodogaya-ku,
Yokohama-shi, Japan